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Causal Inference Thinking of Elementary School Teacher Professional Education Program Students in Determining Digital Strategies to Solve Mathematical Problems

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Abstrak. Tujuan penelitian ini mengkaji *causal inference thinking* Mahasiswa PPG PGSD dalam memecahkan masalah matematika. Penelitian ini menggunakan pendekatan kualitatif dengan jenis studi kasus. Subjek penelitian ini adalah empat mahasiswa PPG prajabatan PGSD UM. Instrumen penelitian ini diantaranya adalah peneliti, rubrik indikator, lembar validasi, catatan peneliti, masalah matematika, jaringan internet, laptop, dan *handphone*. Subjek penelitian sebagai sumber data menghasilkan data yang dianalisis berupa jawaban tertulis dan hasil rekaman wawancara. Teknik analisis data kualitatif yang digunakan dalam penelitian ini adalah model interaktif. Hasil penelitian ini menunjukkan bahwa *fast causal inference* ditandai dengan mengungkapkan kefamilieran dengan masalah matematika yang dipecahkan, mengungkapkan kefamilieran dengan platform digital yang diakses untuk memecahkan masalah matematika, mengakses platform digital dengan kata kunci, mengorelasikan karakteristik informasi dengan platform digital tertentu, dan mengakses platform digital tertentu secara spontan. *Slow causal inference thinking* ditandai dengan mengakses lebih dari satu platform digital untuk memahami suatu informasi dan membaca teks soal matematika secara berulang-ulang. Platform digital yang dianggap solutif oleh para subjek adalah platform Google dan YouTube.

Kata kunci: *causal inference thinking*, pendidikan profesi guru, platform digital

Abstract. *This research aims to examine the causal inference thinking of PPG PGSD students in solving mathematical problems. This research used a qualitative approach with a case study type. The subjects of this research were four pre-service PPG students from PGSD UM. The instruments for this research include researchers, indicator rubrics, validation sheets, researcher notes, mathematical problems, internet networks, laptops, and handphones. Research subjects as data sources produce data that is analyzed in the form of written answers and recorded interviews. The qualitative data analysis technique used in this research is the interactive model. The results of this research show that fast causal inference thinking is characterized by expressing familiarity with mathematical problem solving, expressing familiarity with accessing digital platforms to solve mathematical problems, accessing digital platforms with keywords, correlating the* *characteristics of information with specific digital platforms, and Accessing specific digital platforms spontaneously. Slow Causal Inference Thinking is characterized by accessing more than one digital platform to understand a piece of information and read the math problem text repeatedly. The digital platforms that the subjects considered to be a solution were the Google and YouTube platforms.*

Keywords: *causal inference thinking, professional teacher education, digital platforms*

INTRODUCTION

Digitalization has penetrated all aspects of life, including solving everyday problems that apply mathematical concepts (Alsaadoun, 2022; Jamil et al., 2022; Listiawan et al., 2024; Priyakorn, 2024). Digitalization offers a new dimension of significant student learning experiences in everyday life (Rofiki et al., 2024). Mathematics is a science that includes concepts with the broadest application in life (Alam, 2020; Segarra & Cabrera-Martínez, 2023; Urhan et al., 2024). Thus, the ability of elementary school teachers, professional education programs students, or PPG PGSD Pre-Service (elementary teacher education) students to apply mathematical concepts to solving life and learning problems in elementary school using digital platforms as a strategy is essential.

Dual process theory has several study topics that study problem-solving, including dual process interactions, intuition, teacher intervention, and feeling of rightness (FOR). Meanwhile, problem-solving is still the main study in mathematical thinking research from the perspective of students and teachers at various levels (Gunawan et al., 2022; Haataja et al., 2019; Sousa & Mendes, 2017). Research on problem-solving within the framework of dual process theory has a new topic that is developing rapidly, namely dual process interaction (Diederich, 2023; Susiswo et al., 2024). Dual process interaction is the most developed topic because it underlies other issues. Dual process interactions are categorized into two large frameworks: default-interventionist and parallel-competitive interactions (Darmawan et al., 2020, 2021). Part of the dual process interaction is causal inference thinking. Causal inference thinking involves more than one type of dual process interaction that produces various response categories. However, no one has

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formulated a combination of dual process interactions in causal inference thinking (Dana & Pearl, 2018).

Causal inference thinking is drawing conclusions based on cause and effect analysis (Dana & Pearl, 2018). Causal inference thinking occurs in solving mathematical problems because it is impossible for someone to solve a problem without carrying out cause and effect analysis (Allaire-duquette & Stavy, 2019; Darmawan et al., 2021; De Neys, 2018). Causal inference thinking occurs due to the interaction of dual processes, namely, the interaction between system 1 and system 2. System 1 is a mental activity that produces responses automatically so that its characteristics are fast (DeCoster & Smith, E., 2002; Lem, 2015; Susiswo et al., 2024; Voudouri et al., 2023). Meanwhile, system 2 is a mental activity in producing responses through the process of matching characteristics between information so that the characteristics are slow (Darmawan et al., 2021; Derous et al., 2015; Stanovich & Toplak, 2023; Trippas et al., 2016).

Millennial teachers tend to think automatically and utilize digital platforms when solving problems, compared to thinking analytically without digital platforms. When choosing a digital platform as a problem-solving strategy through causal inference, thinking quickly or slowly impacts the effectiveness and level of success in solving problems of prospective professional elementary school teachers (Darmawan et al., 2020). Figure 1 is the result of a preliminary study that shows the advantages of fast causal inference thinking and slow causal inference thinking.

Solve the following problems by utilizing electronic media.
A cell phone company charges IDR 0.12 for connecting a call plus IDR 0.08 per minute or any part thereof (e.g., a phone call lasting 2 minutes and 5 seconds costs (IDR0.12 + 3 × IDR0.08). Sketch a graph of the cost of making a call as a function of the length of time t that the call lasts. Discuss the continuity of this function.

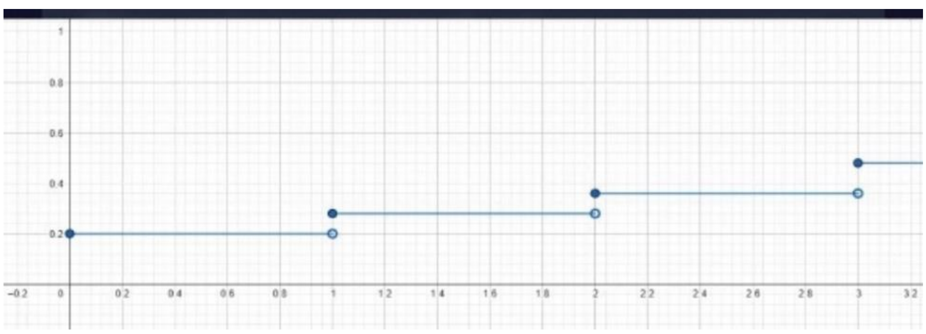

Figure 1. Student Answer

Figure 1 is a function image produced by PGSD Pre-Service PPG students. Figure 1 was produced through fast and slow causal inference thinking. Fast causal inference thinking occurs when the subject analyzes the causes and effects of using the GeoGebra digital platform. Meanwhile, Slow causal inference thinking occurred when the student compared Figure 1 with a YouTube tutorial. Student statements that reveal this are as follows.

> *"I have never made a graph like this before. Through GeoGebra and YouTube, students were able to produce this graph. This graph is the correct answer to the question"*

Fast causal inference thinking is sometimes more effective and successful in solving problems than slow inference thinking and vice versa (Howarth et al., 2022; Lawson et al., 2020; Pavlova, 2024). Until now, research results or theories have not been able to explain this phenomenon (Dana & Pearl, 2018; Pavlova, 2024; Susiswo et al., 2024). Therefore, it is crucial to study the effects of fast causal and slow inference thinking on the effectiveness and success of digital platforms as a problem-solving strategy. The following is Figure 2, which illustrates the relationship between the elements studied in this research.

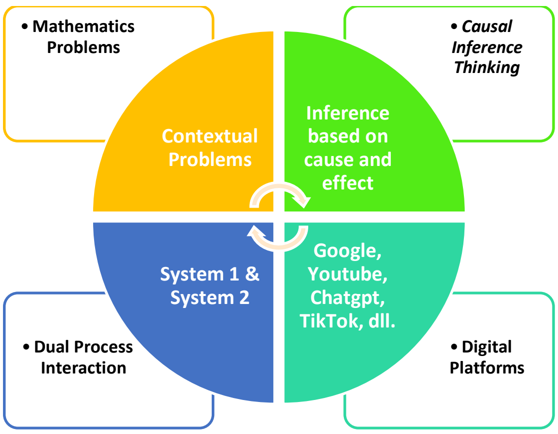

Figure 2. Causal Inference Thinking & Digital Platforms

Based on Figure 2, if this research is not carried out, then PPG PGSD Pre-Service students will not know the causes of difficulties in solving mathematical problems. PPG PGSD Pre-Service students do not know cause and effect analysis,

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which risks causing challenges and even failure in solving mathematical problems, and students do not know digital platform indicators relevant to the mathematical issues being solved. The following Table 1 summarizes the position of this research when compared with previous research

Table 1. Research Position

Researcher and Year	Title	Focus
(Firnanda et al., 2023)	Eksplorasi interaksi parallel-competitive mahasiswa dalam pemecahan masalah program linear	System 1 and System 2 are active in parallel or simultaneously
(Darmawan, 2023)	Interaksi Default-Intervionist (DI) Siswa Sekolah Dasar dalam Memecahkan Masalah Geometri	The response produced by system 1 triggers the activation of system 2
(Susiswo et al., 2024)	Exploring default-interventionist interaction of thinking activity types on probability problem-solving	Instrument characteristics that trigger default-interventionist interactions
This research	Causal Inference Thinking of Elementary School Teacher Professional Education Program Students in Determining Digital Strategies to Solve Mathematical Problems	The interaction of system 1 and system 2 that occurs in decision-making involving cause-and-effect analysis

Based on Table 1, this research is novel in the focus of its study, namely the dual process interactions that occur during cause and effect analysis. Previous research only focused on one type of dual-process interaction. Firnanda et al., (2023) only focus on parallel-competitive interactions. Meanwhile, Darmawan, (2023) and (Susiswo et al., 2024) only focuses on default-interventionist interactions. because of that, the aim of this research is to 1) Examine the causes of the fast causal inference thinking of PPG PGSD Pre-Service students in choosing digital platforms to solve mathematical problems that produce solutions, 2) Examining the causes of the fast causal inference thinking of PPG PGSD Pre-Service students in choosing digital platforms to solve mathematical problems that do not produce solutions, 3) Examining the causes of the slow causal inference thinking of PPG PGSD Pre-Service students in choosing digital platforms to solve mathematical problems that produce solutions, and 4) Examining the causes of the slow causal inference thinking of PPG PGSD Pre-Service students in choosing digital platforms to solve mathematical problems that do not produce solutions.

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RESEARCH METHOD

This research used a qualitative approach with a case study type. This research was conducted at the Universitas Negeri Malang (UM). The subjects of this research were PPG PGSD Pre-Service students in 2024.

The researchers involved three UM mathematics department lecturers, three UM mathematics education students, and four PPG PGSD Pre-Service students as subjects of this research. The research instrument comprises mathematical problems, audio-visual recording tools, indicator rubrics, interview guides, validation sheets, and gadgets. The mathematical problem used is presented in Figure 1 in the introduction section. Meanwhile, the indicator rubric and research procedures are presented in Table 2 and Table 3.

Table 2. Causal-Inference Thinking Indicator Rubric

Causal Inference Thinking Category	Indicator
Fast Causal Inference Thinking	Expressing familiarity with the mathematical problem solved
	Expressing familiarity with accessing digital platforms to solve mathematical problems
	Accessing digital platforms with keywords
	Correlating the characteristics of information with specific digital platforms
	Accessing specific digital platforms spontaneously
Slow Causal Inference Thinking	Expressing unfamiliarity with the math problem solved
	Accessing more than one digital platform to understand a piece of information
	Reading the math problem text repeatedly
	Accessing digital platforms without specific reasons

Table 3. Research Procedure

No	Procedure	Stage	Description
1	Preparation	Instrumentation and Preliminary Study	Develop the research instruments and validate them with experts. The validators for this research consist of two elementary mathematics education experts holding the position of professor and two mathematics experts holding the position of professor with over 15 years of teaching experience. A preliminary study was

			also conducted to test the instruments at this stage.
2	Data collection	Provision of mathematical problem	Prospective subjects are allowed to solve the problem until they feel completed
		Interview	Prospective subjects are interviewed regarding their responses and evaluated using a rubric of indicators to determine their selection as subjects
3	Data analysis	Data reduction	The data that does not support the research objectives will be sorted out
		Data categorization	Categorizing data into fast causal inference thinking and slow inference thinking
4	Data presentation	Exposition of results	Presenting the data of each research subject
			Presenting the research findings
5	Conclusion	Conclusion	Formulating the causes of fast and slow causal inference thinking in choosing a digital platform as a strategy for solving mathematical problem

RESULT AND DISCUSSION

This section explains the subject's forms of causal inference thinking when using digital platforms as a problem-solving strategy. Sequentially, fast causal inference thinking and slow causal inference thinking are presented for the subject of this research.

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Fast Causal Inference Thinking

Fast causal inference thinking is concluding quickly through cause and effect analysis. In this research, fast causal inference thinking occurs in five subject activities in solving mathematical problems. The following is explained in detail.

Expressing familiarity with mathematical problem-solving and accessing digital platforms to solve mathematical problems is the subjects' first fast causal inference thinking. This statement is revealed in Interview 1.

***Researcher**: Have you ever solved other problems similar to this problem? explain*

***Subject 1**: I once solved this problem in high school while participating in OSK (District/City Mathematics Olympiad).*	***Subject 3**: I once completed a problem to make a graph that was similar to this problem. At that time, I was given a problem making a graph containing data on friends' hobbies in class.*
***Subject 2**: I solved this problem but used Indonesian, making it easier to understand.*	***Subject 4**: Yes, I once solved a similar problem at school.*

Interview 1

The subject's statement in Interview 1 shows fast causal inference thinking. The subject's System 1 is active because information is considered familiar, namely functions and graphs. System 1 is active, indicating that an automatic process is occurring. Therefore, subjects spontaneously access digital platforms. Subjects spontaneously chose a digital platform commonly used in solving problems. The following is the subject's statement in Interview 2.

***Researcher**: Why did you spontaneously think of using this digital platform?*

***Subject 1**: When reading the questions, I found some vocabulary I did not know, especially in mathematics. Sometimes, the language used in the scientific field differs from the written language. Therefore, I opened Google Translate to confirm the meaning of the vocabulary*	***Subject 3**: I think this is to avoid mistakes in interpreting the question in the question. Because if you misinterpret it, you will also misunderstand the question, resulting in errors in answering it.*
***Subject 2**: I took this step to provide insight or an illustration in answering the questions I had just encountered because I had difficulty understanding story problems in making a graph*	***Subject 4**: Limited understanding of English, so requires the help of Google Translate*

Interview 2

Interview 2 shows the similarity of the four research subjects in giving reasons for their spontaneous thinking. Subjects who chose the first digital platform to access reasoned that the digital platform was a solution based on their learning experience. The following is Interview 3, which reveals the first digital platform each subject accesses and other digital platforms supporting problem-solving.

***Researcher**: Have you accessed all the digital platforms you use to answer questions before? Mention those who have and those who have not*

***Subject 1**: I have and can even be said to access Google, Google Translate, and YouTube often.*

***Subject 2**: Yes, I have used these digital platforms; the ones I have accessed are YouTube and Canva learning video media. In this case, the learning media I have never had access to is that I have not found electronic media that can be used to introduce mathematical formulas more simply and easily for students to understand.*

***Subject 3**: Yes, I have; the digital platforms I have used are Google Translate and YouTube. I have used the platform above before.*

***Subject 4**: Yes, I have used the Google platform, Google Translate, and Ms. Excel before.*

Interview 3

Based on Interview 3, the digital platform first accessed by Subject 1, subject 3, and Subject 4 was Google Translate. Google Translete is used to understand the core of the problem. Meanwhile, subject 3 carried out the same goal with YouTube. In other words, the subjects expressed familiarity with accessing digital platforms to solve mathematical problems. So, in the first fast causal inference thinking, only system 1 is active, indicating that an automatic process is occurring.

After the subject understands the core of the problem through system 2, namely the conscious process, system 1 is active again. The occurrence of an automatic process marks the activation of system 1. The automatic process generates keywords. Subjects use keywords to make it easier to produce solutions. The following is Interview 4, which reveals this.

***Researcher**: Do you use keywords to answer questions using digital platforms? What keywords? What digital platform is used? Why do you use keywords?*

***Subject 1**: I was looking for keywords on this digital platform: "continuity of the function" and "how to make a function graph using Microsoft Word."*

***Subject 3**: I use keywords to answer digital platform questions. In this context (based on the question above), I use the keywords "mathematics function chapter,"; "how to*

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	graph functions," ''completion of function graph case studies'', "function graph calculus." Using these keywords will make searching for things I want to know easier.
***Subject 2**: I use these keywords to make it easier to find several references when answering questions.*	***Subject 4**: I copied the questions first. When the question I was looking for specifically was not in my search, I just determined keywords to be able to find similar questions. The keywords used are graph and function*

Interview 4

Subject 1 uses the keywords continuity of the function and how to make a function graph using Microsoft Word. Subject 2 uses keywords to make problem-solving easier. Subject 3 uses the keywords how to graph functions, completion of function graph case studies, and function graph calculus. Subject 4 uses the keywords graph and function. All subjects of this research use the same keywords, namely function and graph.

Correlating the characteristics of information with specific digital platforms also marks the occurrence of fast causal inference thinking in the subjects. This is revealed through Interview 5.

***Researcher**: Is there certain information in the question that causes you to use a certain digital platform automatically? Name it and explain why*

***Subject 1**: When I saw the questions in English, I immediately thought of opening Google Translate to look for some vocabulary that I still did not know and had an explicitly different context. When I already knew the meaning of the vocabulary, I opened Google with the same keywords to find out what continuity and function mean. I wanted to see a visualization of the phrase.*	***Subject 3**: Yes, the first is regarding the use of foreign language in the question, which made me find out the meaning of the question via Google Translate. Then, regarding the material that I felt was difficult, I needed a digital platform to find a way to solve the problem.*
***Subject 2**: The information or references I found on the platform showed several answers that had references so that I could use them as references that had a basis and came from clear sources.*	***Subject 4**: This was the first time I had worked on this question, so I automatically looked for information using digital platforms to increase my understanding of the question I was working on.*

Interview 5

Based on Interview 5, subject 1, subject 3, and subject 4 accessed Google Translete to understand the essence of the problem. Meanwhile, subject 2 accessed Google Gemini to understand the essence of the problem. Subject. The process of understanding the problem is an indication that system 2 is active. In this condition, the conscious process indicates that system 2 is active. Once the essence of the problem was understood, the subjects spontaneously accessed the digital platform deemed most relevant in generating answers. This spontaneity marks the activation of System 1, which is an automatic process. Here is Interview 6 which reveals this.

***Researcher**: Spontaneously after understanding the question, what digital platform are you thinking about using? Why?*

***Subject 1**: After understanding the problem, of course, the platform I opened was YouTube to find tutorials for making function graphs in Microsoft Word. YouTube will provide several video tutorials with language and displays that are easy to understand.*

***Subject 2**: The digital platforms that I often use are Google Gemini and Perplexity because they can help and make the references that I develop to answer questions based on clear and easy-to-access sources.*

***Subject 3**: The digital platform that I spontaneously thought of after understanding this question was YouTube. Through this platform, I hope to get a video tutorial on working on questions with the same case as this question. I find it easier to understand and learn in video form.*

***Subject 4**: The digital platform that I thought of first was Youtube*

Interview 6

Based on Interview 6, subjects spontaneously accessed YouTube, Google Gemini, or Perpelxity AI. Subjects who access YouTube hope to solve the problem by following the procedures presented. Meanwhile, subjects who access Google Gemini or Perplexity hope to produce instant answers without going through deep reflection.

Slow Causal Inference Thinking

Three indicators characterize slow causal inference thinking in this research. The subjects accessing more than one digital platform to understand a piece of information is one of the other indicators. The subjects accessing more than one digital platform is a representation of problem-solving steps. Each digital platform is used for one step in producing a solution. In other words, this first indicator marks the activation of system 2. The occurrence of conscious processes characterizes an active system 2. A conscious process occurs when subjects switch from one digital platform to another. The decision is made by matching the characteristics of the problem-solving carried out with the learning experience. The learning experience used is switching to another digital platform when solving a problem using the previous digital platform is deemed not to produce a solution. This is revealed through Interview 7.

***Researcher**: How many digital platforms do you use? Explain why you use it*

***Subject 1**: I use three platforms; namely Google Translate, Google, and YouTube. To find out the meaning of some vocabulary that I still don't understand, I opened Google Translate. After I knew the meaning, I opened Google to find out the meaning using the scientific language used and saw the visualization. After I understood the meaning of the question, I opened YouTube so I could follow a tutorial on how to create a function graph using Microsoft Word.*	***Subject 3**: There are 4 digital platforms that I use to solve these problems. On three platforms (Google Translate, YouTube, and Google) I intended to look for tutorials on how to do questions with the same case. Then 1 platform (Quizlet.com) that I had never heard of before, actually gave results that were more in line with my expectations.*
***Subject 2**: There are three digital platforms that I often use. The reason I use some of these platforms is because they are easy to access and have answers with clear reference sources.*	***Subject 4**: To work on this question I used Google Translate to translate the question. Then searched Google for the answer and when I couldn't find the answer I searched through keywords on Google Scholar. When I still couldn't find the answer, I opened a tutorial to do the problem via YouTube.*

Interview 7

Based on Interview 7, subject 1 accessed three digital platforms, namely Google Translate, Google Search Engine, and YouTube. Google Translate is used to find out the meaning of some vocabulary that is still not understood. Google search engine is used to find out the meaning of scientific language used in mathematical problems and see visualizations. After Subject 1 understood the meaning of the question, subject 1 opened YouTube to follow a tutorial on making function graphs using Microsoft Word. Subject 2 accessed three digital platforms for the reason that they were easy to access and had answers with clear reference sources. The three digital platforms accessed respectively are Google Gemini, Google Perplexity, and Google Translate. Subject 3 accessed four digital platforms, namely Google Translate, YouTube, and Google/Google Search Engine to look for tutorials on how to do questions with the same case. Then, a digital platform, Quizlet.com, which Subject 3 had never accessed before, was considered to provide results that were more in line with expectations. Subject 4 accesses three digital platforms. Google Translate was used to translate the questions. Google was used

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to search for the answer and when subject 4 thought he could not find the answer, subject 4 searched through keywords on Google Scholar. When subject 4 still couldn't find the answer, subject 4 opened a tutorial to solve the problem via YouTube.

The subjects reading the math problem text repeatedly is the second indicator of slow causal inference thinking in this research. This is revealed through Interview 8.

Researcher*: Do you read questions over and over again? Why?*

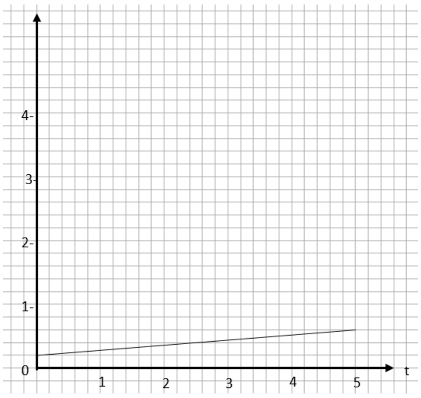
Subject 1*: Yes, I read the questions several times so that I could understand the meaning of the questions presented and understand what was wanted in the questions.*	***Subject 3****: Yes, I read the questions over and over again to understand them. Because I don't understand calculus because I am not a graduate of mathematics education so I still find it difficult to understand the questions in this question.*
Subject 2*: I read the question repeatedly if I feel the question is quite difficult and then I find it, because it is to understand the question and give the maximum answer.*	***Subject 4****: I read this question over and over again because it was my first time doing such a question. So my understanding of this problem is limited*

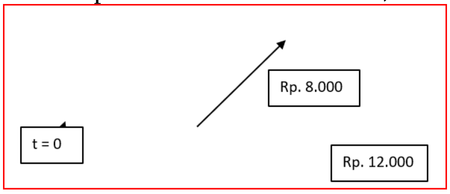
Interview 8

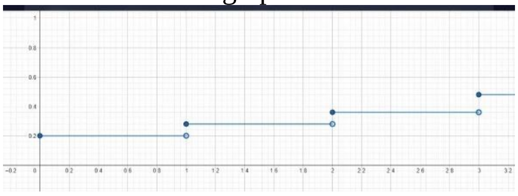
Based on Interview 8, the subjects read the questions repeatedly to understand the core of the problem. This indicates that system 2 is active. Conscious processes and empirical-accuracy processes characterize an active system 2 (Susiswo et al., 2024). Conscious processing occurs when subjects match the characteristics of the information in the problem with their learning experiences. The result of this conscious process is that the learning experience is deemed inadequate. Meanwhile, the empirical-accuracy process occurs when subjects try the digital platforms one by one to produce accurate answers. This empirical-accuracy process occurs after the activation of the conscious process.

Comparison of Subjects' Answers

The following presents a summary of the subjects' flow of thinking in solving mathematical problems using digital platforms. This summary also shows a comparison of the digital platforms used by the subject and the results in the form of written answers.

Subject	Flow of Thinking: The flow of digital platforms used	Answer
1	Google Translate⟶Google Search Engine⟶YouTube	Given: $IDR0.12$ => Telephone costs $IDR0.08$ every minute $IDR0.12 + (3 \times IDR0.08)$ for calls lasting 2 minutes and 5 seconds Asked: Function Answer: Let's say that "y" is the fee that must be paid, and "t" is the number of minutes; So, we get the equation: $Y = 0.12 + (t + 1)\, 0.08$ $Y = 0.12 + 0.08\, t + 0.08$ $Y = 0.20 + 0.08$ 
2	Google Gemini⟶Google Perplexity⟶Google Translate	Cell phone call costs: $B\,(t) = IDR12{,}000$ Call time: t (in minutes) Call Cost Function: $B\,(t) = 0.12 + 0.08t$ Graphic sketch: 1. Initial costs: $IDR12{,}000$

Subject	Flow of Thinking: The flow of digital platforms used	Answer
		2. Cost per minute of call: $IDR8{,}000$  Analysis of the continuity of the cost function B (t) is the continuity of all t values that are not negative, this is based on a graph that has no gaps or jumps. The reason is, that the initial fee of IDR12.00 is added constantly for all calls, regardless of duration, the longer the call the higher the fee. The initial cost and the ongoing cost per minute include the total call cost B(t). Conclusion: The cell phone call cost graph is a straight line starting from the point (0,0.12) and has a slope of 0.08. The cost function B(t) is a continuous function for all non-negative values of t.
3	Google Translate⟶YouTube⟶Google Search Engine⟶Quizlet	Initial cost = IDR 0.12 Additional fee = IDR 0.08/minute or part thereof For example, 2 minutes 5 seconds (this is part of the next minute so it is rounded to 3 minutes) $= IDR0.12 + 3 \times IDR\ 0.08$ $= IDR0.12 + IDR0.24$ $= IDR\ 0.36$ These results show that the longer the duration of the telephone call, the higher the costs incurred, or it could be said to be directly proportional. During the same minute, the graph will always be the same and will increase in the next minute.

Subject	Flow of Thinking: The flow of digital platforms used	Answer
		The function graph is as follows: 
4	Google Translate⟶Google Scholar⟶YouTube⟶Quill bot	Let *C(t)* represent the cost of making a call that lasts t minutes. The cost consists of two parts: 1. A fixed cost of IDR 0.12 for connecting the call. 2. A variable cost of IDR 0.08 for each minute or any part thereof. So, the cost function *C(t)* can be expressed as: $$C(t) = 0.12 + 0.08t$$ Graph: 1. Y-Intercept: The fixed cost component is IDR 0.12, so the graph intersects the y-axis at (0, 0.12). 2. Slope: The slope of the graph is the variable cost per minute, which is IDR 0.08. This means for every minute the call lasts, the cost increases by IDR 0.08. 3. X-Intercept: To find the x-intercept, we set *C(t)* = 0 and solve for *t*: $0.12 + 0.08t = 0$ $0.08t = -0.12$ $t = \frac{-0,12}{0,07}$ *t* = -1.5 Since time cannot be negative in this context, the x-intercept is not relevant in this scenario. So, the graph is a straight line starting at te point $(0, 0.12)$ with a slope of (0.08), representing the increase in cost per minute. It extends indefinitely in the positive direction of the x-axis.

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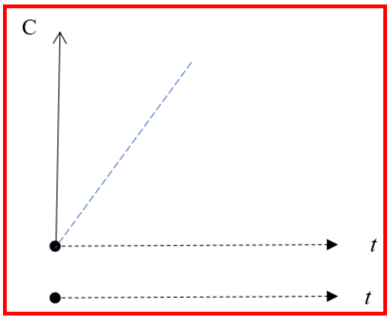
Subject	Flow of Thinking: The flow of digital platforms used	Answer
		The graph would look like this:  This line has a positive slope, indicating that as the duration of the call increases, so does the total cost.

Based on the subject's flow of thinking in producing answers, fast causal inference thinking, and slow causal inference thinking have very distinctive differences in choosing a digital platform. Fast causal inference thinking is dominated by active system 1. Meanwhile, slow causal inference thinking is dominated by active system 2. However, in fast causal inference thinking, system 2 is active before system 1. Causal analysis in fast causal inference thinking is a representation of system 2 is an active (Susiswo et al., 2024).

Fast causal inference thinking and slow causal inference thinking occurred in the thinking of the research subjects in choosing a digital platform. Both occur alternately during the problem-solving process. Fast causal inference thinking occurs because the subjects are familiar with the given mathematical problem. Slow causal inference thinking occurs because the subject cannot produce answers spontaneously.

Based on the results of the analysis of the subjects' inference thinking, the digital platform that is most popular and is considered to be able to be used to help solve problems at the beginning of problem-solving is Google Translate. This happened because the mathematical problems in this study were presented in English. In other words, this condition explains that PPG students' English language skills are still low. This low English language ability has an impact on the efficiency of problem-solving carried out.

Google's platform is the most popular used by subjects because it is considered the best solution and can provide detailed answers. The Google platforms used by the subjects besides Google Translate are Google Gemini and Google Perplexity. Google Gemini and Google Perplexity are responsive AI (Artificial intelligence) so they are thought to be able to produce answers instantly. The Google platform has indeed become the most popular and has resulted in subjects tending not to think manually but to spontaneously think of a digital platform that suits the problem being solved (Alam, 2020; Alsaadoun, 2022; Angga, 2022; Fitriani et al., 2021). AI has resulted in a shift in prospective teachers' thinking procedures in solving mathematics problems from thinking manually to thinking instantaneously (Bobi et al., 2023; Harharah et al., 2024; Sianturi et al., 2024).

If the Google platform was deemed unable to produce answers, the research subjects accessed YouTube. YouTube has a video tutorial feature that is considered capable of providing explanations to its viewers so that subjects choose it for the need for more in-depth explanations provided by Google. Furthermore, if the subjects felt they were unable to understand the explanation from the YouTube tutorial video, they returned to accessing Google, namely the Google search engine. Google search engine is the most popular search engine in the world because of its ease of access (Fauzi et al., 2020; Freiman & Tassell, 2018; Iyamuremye et al., 2023).

CONCLUSION

Fast causal inference thinking is characterized by expressing familiarity with mathematical problem solving, expressing familiarity with accessing digital platforms to solve mathematical problems, accessing digital platforms with keywords, correlating the characteristics of information with specific digital platforms, and Accessing specific digital platforms spontaneously. Slow causal inference thinking is characterized by accessing more than one digital platform to understand a piece of information and reading the math problem text repeatedly.

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